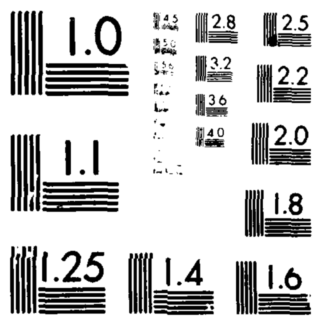
AD-A081 243 MASSACHUSETTS INST OF TECH CAMBRIDGE FLIGHT TRANSPOR--ETC F/G 1/5
WIDE BODY AIRCRAFT DEMAND POTENTIAL AT WASHINGTON NATIONAL AIRP--ETC(U)
SEP 77 R AUSTROTAS, M TAYLOR, W FROMME

UNCLASSIFIED FTL-R-76-6 FAA-AVP-77-37 NL

1 OF 1
AD
A081243

END
DATE
FILMED
3-80
DDC



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

REPORT NO. FAA-AVP-77-37

LEVEL II

WIDE-BODY AIRCRAFT DEMAND POTENTIAL AT WASHINGTON NATIONAL AIRPORT

September, 1977

Technical Supplement to
The Metropolitan Washington Airport Policy Analysis

Prepared for

UNITED STATES DEPARTMENT OF TRANSPORTATION
Federal Aviation Administration

Office of Aviation Policy
Washington, D.C. 20591

Technical Report Documentation Page

1. Report No. FAA-AVP-77-37	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle WIDE BODY AIRCRAFT DEMAND POTENTIAL AT WASHINGTON NATIONAL AIRPORT		5. Report Date SEP[redacted] 1977
		6. Performing Organization Code
7. Author(s) R. AUSTROTAS, M. TAYLOR, W. FROMME (TECH. MONITOR)		8. Performing Organization Report No. FTL REPORT R76-6
9. Performing Organization Name and Address FLIGHT TRANSPORTATION LABORATORY MASSACHUSETTS INSTITUTE OF TECHNOLOGY CAMBRIDGE, MASSACHUSETTS 02139		10. Work Unit No. (TRAIS)
		11. Contract or Grant No.
12. Sponsoring Agency Name and Address OFFICE OF AVIATION POLICY FEDERAL AVIATION ADMINISTRATION WASHINGTON, D.C. 20591		13. Type of Report and Period Covered
		14. Sponsoring Agency Code FAA (AVP-210)

15. Supplementary Notes

NONE

16. Abstract

The Federal Aviation Administration (FAA), as owner and operator of the Metropolitan Washington Airports, Washington National and Dulles International, is issuing a policy statement to guide development and operation of these facilities into the 1990's. The FAA's Metropolitan Washington airport policy establishes a balance between a complex set of criteria which reflect transportation service, investment requirements and environmental impacts.

This report presents the results of an analysis of the feasibility and future impact of allowing service by wide-body aircraft into National Airport in Washington.

The report concludes that by 1990, wide-body aircraft, if authorized, would constitute approximately 20 percent of all air carrier operations at National. This is equivalent to an average flight schedule of four wide-body departures per hour.

17. Key Words METROPOLITAN WASHINGTON AIRPORTS AIRPORT POLICY ANALYSIS WIDE BODY AIRCRAFT	18. Distribution Statement

19. Security Classif. (of this report) UNCLASSIFIED	20. Security Classif. (of this page) UNCLASSIFIED	21. No. of Pages	22. Price

Form DOT F 1700.7 (8-72) Reproduction of completed page authorized

Table of Contents

Acknowledgment

This report was prepared under sponsorship of the Federal Aviation Administration. The authors would like to acknowledge the helpful assistance and guidance of Mr. William R. Fromme of the FAA.

1. Introduction

At present there is concern regarding the feasibility and future impact of allowing service by wide-body aircraft into National Airport in Washington. Some of the important issues are:

(i) To what extent would the air carrier traffic change at Dulles and National Airports if wide-bodies were allowed at National? In addition, would this reduction in the quality of service (i.e. trip convenience and time) result in diversion of passengers to other modes of transportation in short-range markets?

(ii) Could airlines maintain a high level of service to Metropolitan Washington and still make a profit serving their Washington markets?

(iii) What would be the effect of changing the existing quota of 40 operations per hour at National Airport?

FA-7, an air transportation simulation model developed in the Flight Transportation Laboratory at M.I.T. is well suited for analysis of these policy-oriented questions and was used to obtain answers to a series of hypothetical scenarios regarding wide-body aircraft use at the two Metropolitan Washington airports.

2. Description of FA-7 and FA-7.1

FA-7 primarily produces an optimal network of services subject to certain system constraints. The model may be thought of as a basic planning device for an airline. Although it does not permit the inclusion of all the details that are relevant for a coherent description of daily airline management, it incorporates major factors which are necessary for final managerial decisions. It provides answers that simultaneously satisfy the adherence to external industry regulations and specific internal economic/operational objectives. Typically the model is driven by the objective of maximizing profits.

The fundamental component of FA-7 is a linear program which can be solved by standard computer routines. The basic elements of the system are considered to be city-pair markets. Consequently, constraint equations that describe demands in these markets and responses to fares as well as frequency of service are the framework of the linear program. Other constraints ensure that sufficient capacity is provided in the city-pair markets.

Probably the most important feature of FA-7 is the fact that it allows for investigation of the behavior of airlines to changes in demand subject to supply constraints. It is possible to incorporate within the model both business and pleasure demand. The former is most sensitive to frequency of service and the latter to changes in fares. The model is capable of providing a fleet assignment schedule that stimulates the greatest demand in each market given the physical limitation and operating cost for each type of aircraft in the fleet. In markets where low differential cost of capacity exists (e.g. weak segments, tag end or shuttle) fares may be altered so that additional pleasure traffic would be attracted. It is

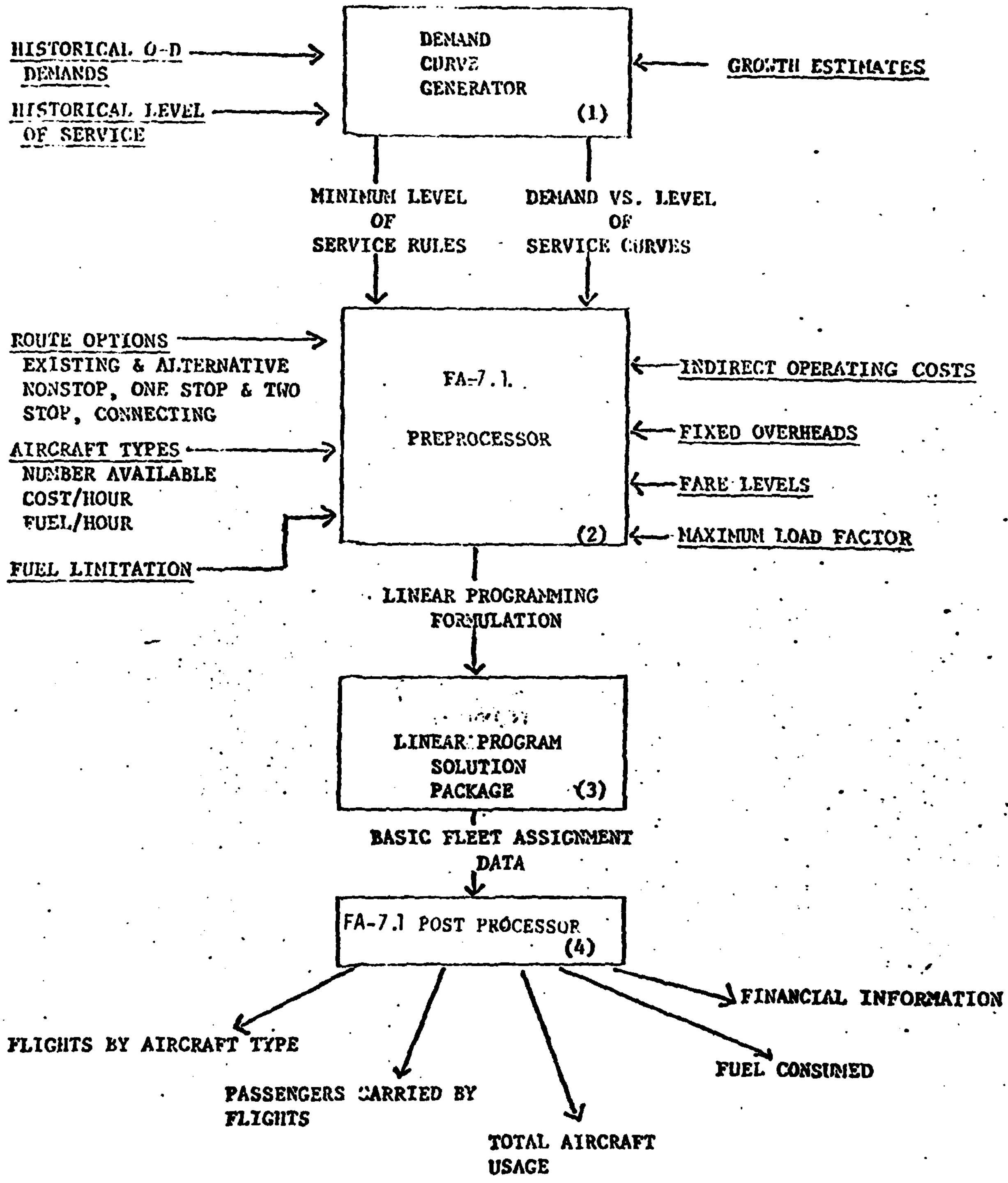
important to note that both aircraft and traffic movement are assumed symmetrical for the system, hence the size of the program is halfed. Further details on the model's characteristics can be found in reference 1.

It is possible to develop a sub-series of models under FA-7 since it allows for a variety of major extensions such as connecting passengers in the system and increase in the link load factors. Its adaption for the wide-body problem of Metropolitan Washington was labelled FA-7.1. The prime feature of FA-7.1 is that fares are held constant under the assumption that markets affiliated with Washington consist predominantly of business traffic. Consequently, allowance for pleasure traffic is omitted in the demand input.

Figure 1 depicts the information flow employed in FA-7.1 where each of the four blocks represents a computer program. As its name implies, the preprocessor is responsible for the correlation and presentation of the system data in a manner consistent with that of the input format of the linear program solution package. The system data consists of a set of feasible routes, aircraft types and their specifications, traffic demand and other city-pair market characteristics.

In order to simultaneously achieve a "complete" city-pair description and exploit the capabilities of the model it is necessary to create from the network all the feasible routes of the individual markets. Since connections are not being considered, route feasibility is directly dependent on the physical limitations of the aircraft fleet. A route options program external to the model was developed primarily for this objective. Input data consisted of all the stations of the system along with their market distances, available aircraft types and their ranges. The aggregate of aircraft, routes, city-pairs and stations was also provided in adherence to the program logic. The above resulted in the provision of two sets of

Figure 1: FA-7.1 Information Flow



coded data. Sample cards from each are presented below.

1 215 FFFF 1 16

1 = label of route of the network

215 = statute miles separating stations of the market

FFFF = results from a logical input variable "ACOK"; here all four types of aircraft are capable of servicing the market. Logical F allows the designated aircraft to fly the route; logical T prohibits the aircraft on that route.

1 16 = stations of the market, i.e. NYC WAS.

The card is best described as a "route feasibility card".

The second card is simply a summary of link structure of each market.

68 39 11

68 = label of route of network

39 = market 39 comprises first link of route, i.e. LAX STL

11 = market 11 comprises second link of route, i.e. STL WAS.

Both a wide and narrow body aircraft were created for the Washington study from cost/capacity relationships. The following code names were used:

WDCA = wide-body allowed into National

NDCA = narrow-body allowed into National

WIAD = wide-body allowed into Dulles

NIAD = narrow-body allowed into Dulles

The direct operating cost of each aircraft and their associated fixed indirect costs and the fares for each market allowed for the calculation of operating profits of the system. Cost information, utilization and

physical specifications were supplied on separate cards for each aircraft. A typical input card follows:

NAME	RANGE	CAPB	SERV	APPEAL	$/DEP	$/MI	MPH	UTIL	NO.
WDCA	925	300	1.0	0.80	881	4.341	510	8.0	8000.0

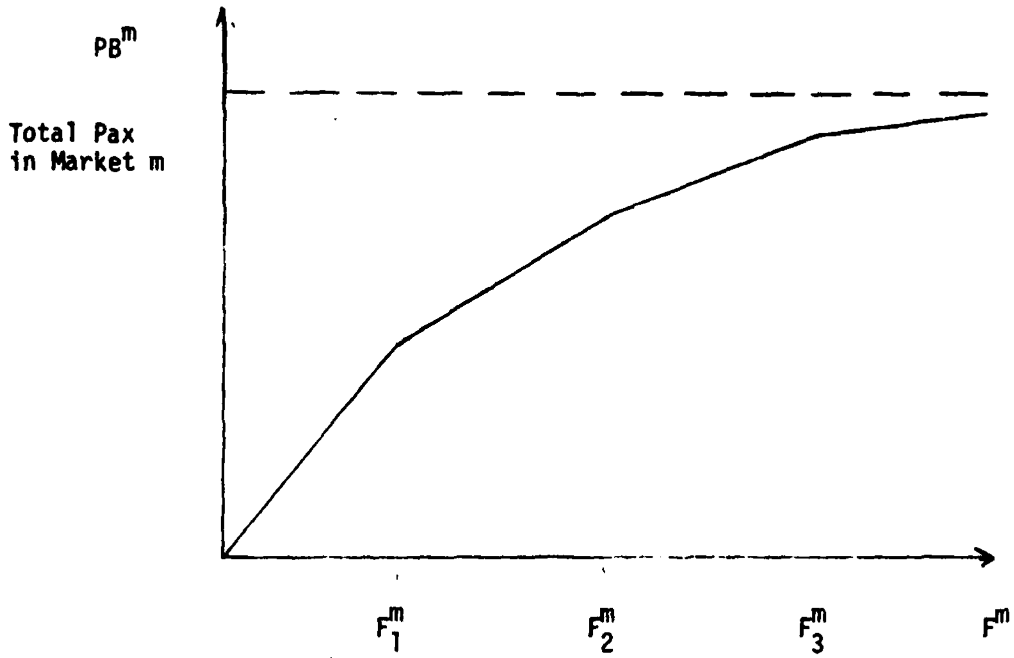
The attractiveness of the aircraft types was defined by appeal and service value factors which were assigned separate but equal values. In essence, if all four aircraft were simultaneously available for a flight, the departing passenger would be indifferent in the selection of an aircraft for the journey. Equal selection of aircraft for assignment was further assured by providing an equal and high number of each type aircraft available (i.e. 8000 per aircraft type).

The model is programmed to optimize over the network of services rather than in each city-pair market. Consequently it produces the market and frequency share for each city-pair relative to this objective. In order to achieve this it is necessary to provide the possibility of selection from a range of demand and equivalent frequency for each market; this is accomplished by a demand frequency curve that is calibrated using historical demand-frequency data.

The demand-frequency curve that is created for each market is illustrated in Figure 2. It is developed from the demand response to frequency and travel time depicted in Figures 3 and 4; both these curves are programmed into the model over all markets using the following equations:

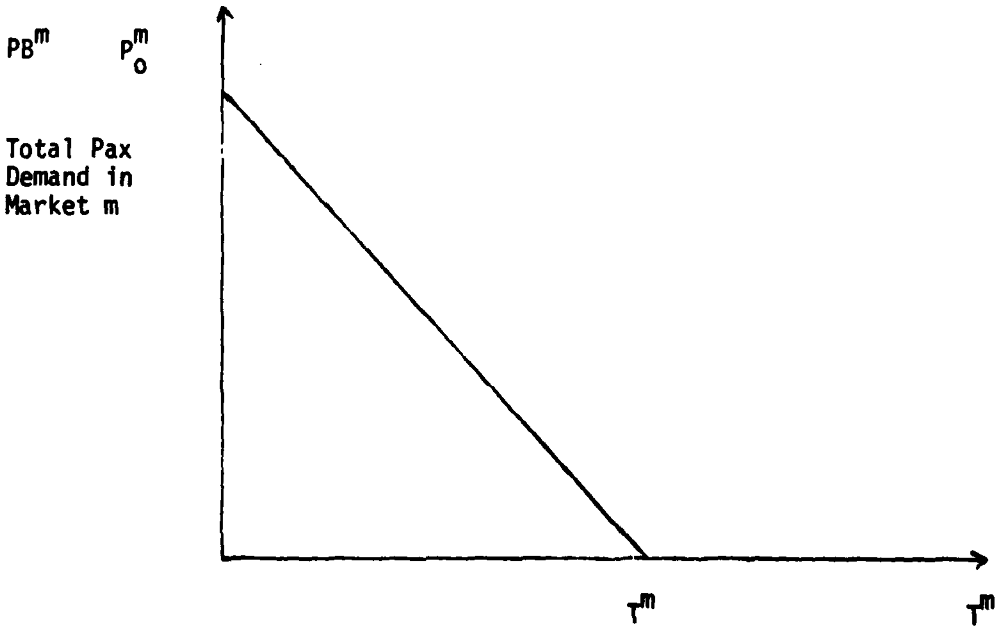
$$PB^m \leq (P_o^m) - T^m \cdot (A^m)$$

$$T^m = T_o^m - \sum_j F_j^m \cdot (B_j^m)$$



Total Services in Market m
Demand-Frequency Curve for Each City-Pair Market

Figure 2



Total Travel Time in Market m

Figure 3

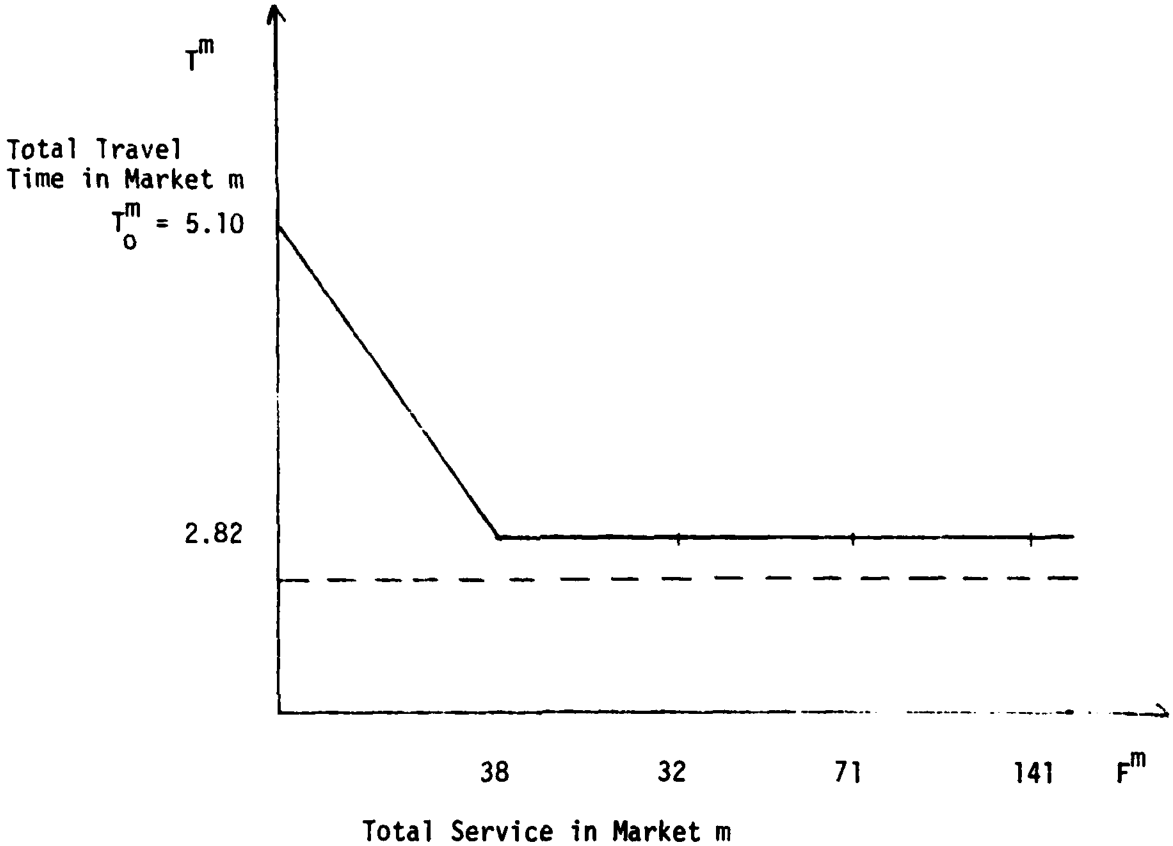


Figure 4

Slope (B_1) Segment 1 = 0.06 Hrs/Freq.
(B_2) Segment 2 = 0.0

The travel T^m in a market is considered to include a fixed portion for access, boarding, flight, and egress and a variable frequency dependent portion for wait or departure inconvenience.

The input data for market demand is best illustrated by considering a city-pair market used in the study. The numbers shown in Figure 4 are those of the 1975 data for the New York-Washington market. The total historical business demand in this market is estimated at 7116 passengers. In the optimum solution for the network the best market share is considered to be

3170 passengers at 62.6 frequencies per day. Since only business demand is considered in this study market prices are fixed and can only be varied for a series of computer runs. Load factor for each market is also fixed and developed externally.

The final section of the model consists of the postprocessor. This program classifies the information produced by the linear program so that the resulting solution for each city-pair market and the activities at the stations may be easily read. The postprocessor also produces a summary of system data which includes such items as total number of vehicles required, total revenue passenger miles and contribution to overhead.

3. Scenarios, Metropolitan Washington Airports

The air transportation system was formulated from twenty-two major hubs that presently have non-stop or one-stop service into Washington. These are divided into two groups as indicated below, with their respective distances from Washington.

Group 1	Distance (Statute Miles)	Group 2	Distance
New York	215	New Orleans	962
Atlanta	540	Dallas/Ft. Worth	1161
Boston	406	Denver	1476
Chicago	591	Houston	1204
Cleveland	297	Los Angeles	2288
Detroit	391	San Francisco	2430
Miami	920	Kansas City	932
Minneapolis	919	Seattle	2317
Philadelphia	133	Las Vegas	2017
Pittsburgh	193		
St. Louis	707		
Tampa	810		

Non-stop service into National is not provided from those large hubs in Group 2.

These hubs can have non-stop flights into Washington via Dulles. The imposed restriction was based on an upper range of 650 miles; however, since service in markets such as Miami-Washington was already well established before the enactment of the law, carriers were not forced to discontinue their operations. The other exceptions to this 650 mile perimeter rule are Tampa, St. Louis, and Minneapolis. (Other "grandfather" cities not considered in this study are Memphis, Orlando, and West Palm Beach.)

The model was programmed specifically to align with the present regulatory constraints being enforced in Metropolitan Washington. In addition,

it was designed to predict the change in ratio of narrow to wide body aircrafts if airlines were allowed to operate the latter into National. Two major factors were adapted in the program in an attempt to depict the forces that would effect this change. First, the four aircraft previously mentioned were assigned the following characteristics:

Name	Range	Capacity	Capacity-Business
WDCA	925	300	300
NDCA	925	80	80
WIAD	4000	300	300
NIAD	4000	80	80

Here the model is literally "forced" to select either a wide or narrow body aircraft with equal restricting range to operate only in Washington affiliated city-pair markets serving National airport. In addition, passengers beyond the 925-mile range were assured service into Washington at Dulles with the supply of long range aircrafts. The imposition of a quota on daily operations at National defined the narrow to wide-body switch that airlines would be forced to adopt. Since the model supplies total departures out of both airports subject to the system constraints it was necessary to include the possibliity of distinguishing National from Dulles departures. Final count to satisfy the National quota was by the equation:

$$\text{TOTAL WDCA} \cdot (\text{DEPVAL}) + \text{TOTAL NDCA} \cdot (\text{DEPVAL}) + \text{TOTAL WIAD} \cdot (\text{DEPVAL}) + \text{TOTAL NIAD} \cdot (\text{DEPVAL})$$

Since the value of 1.0 was assigned to the parameter "depval" for National departures and zero for Dulles departures, the latter were not included in the quota count. The more attractive geographical location of National airport was also incorporated in the model. A parameter "CMIN = 0.8"

expressed the fact that on average an arrival/departure at Dulles was twenty percent less appealing than that at National.

In order to describe the ensuing pattern of changes at Washington over a number of years from the present, a demand factor "PGROWT" was used to estimate the future growth in traffic for each of the years considered. This forecasted growth in demand was provided by the FAA. The values assigned were:

Year	PGROWT
1985	1.90
1990	2.27
1995	2.76

For each year the quota imposed at National ranged from 20 to 40 operations per hour or an equivalent of 100 to 200 departures during the total daily flying hours allowed (7 AM to 10 PM) to the hub cities considered. (These hub destinations from National account for 62% of overall departures and this ratio is assumed to remain constant over the time period considered.)

Table 1 represents daily aircraft activity in the Metropolitan Washington region at the various quotas and for the years being studied. The first result may be regarded as a calibration run with no wide-bodies allowed at National. Allowing wide-bodies with present demand levels reveals that wide-bodies into National, under profit maximization, would be only 3.6% of total operations there.

As the traffic demand is increased for each year a general increase in total daily departures from the metropolitan area occurs. Conversely, as the quota is reduced from 40 to 20 operations per hour within each year, total Washington departures are seen to increase. This seems reasonable since it is expected that airlines would tend to increase their operations

Daily Aircraft Activity for Metropolitan Washington

	Total Departures	Limit on (1) Departures	National WDCA	National NDCA	Dulles WIAD	Dulles NIAD
1975	219	200	0	172.5	10.6	36.6
	218	200	6.4	170.0	4.7	36.5
	208	150	5.4	144.6	4.4	53.9
	221	100	2.3	97.7	4.2	116.7
1985	254	200	44.2	155.8	21.1	33.4
	262	150	40.3	109.6	21.7	90.4
	272	100	15.4	84.6	43.9	128.3
1990	260	200	69.0	131.0	24.9	35.3
	270	150	59.3	90.7	30.5	89.5
	282	100	32.2	67.8	53.0	129.4
1995	280	200	95.7	104.3	35.2	45.1
	291	150	86.8	63.2	40.2	100.7
	300	100	39.4	60.6	83.6	116.8

(1) 200 departures/day ≈ 40 operations/hour

TABLE 1

at Dulles to satisfy the excess demand resulting from the reduced activity at National.

The last four columns of the table represent the mix of aircraft into Washington at both Dulles and National. The general pattern in the aircraft mix for all the years is best identified by studying Table 1 as well as a particular level of operation for each year.

	Total Departures	Limit on Departures	National WDCA	National NDCA	Dulles WIAD	Dulles NIAD
1975	218	200	6.4	170.0	4.7	36.5
1985	254	200	44.2	155.8	21.1	33.4
1990	260	200	69.0	131.0	24.9	35.3
1995	282	200	95.7	104.3	35.2	45.1

TABLE 2

The figures above reveal that for any year National receives the largest portion of traffic into Washington. At a specific quota the substitution of wide for narrow-bodies is coincident with the increase in yearly demand. Between 1975 and 1995 wide-bodies at National increased from 3.6% to 48% and narrow-bodies declined from 96.4 to 52% of the total quota of 40 operations/hour. At Dulles the increasing demand results in an increase of both narrow and wide-body aircraft. Table 1 indicates that the general trend towards wide-body would be maintained for a reduced quota since within each year the ratio of wide to narrow has a relatively small variance at the various levels of operations. Similar behavior can be identified in the simultaneous increase of both types of aircraft at Dulles. Tables 1A through 1D present more details on the traffic between the large hubs and Washington, both passenger and aircraft, based on the 1975 demand, as the quota is changed from 40 to 20

TABLE 1A

Washington Segment Data

Scenario: 1975; No Wide-Bodies Allowed at National

Quota: 40 Operations/Hour
(Calibration Run)

CITY PAIR DATA:

					MARKET DATA															SEGMENT DATA					
NO.	-PAIR--		DIST	FARE	%PLES	PAX	%B	%N	FREQUENCY, 0-4 STOP					PAX, 0 TO 4 STOPS					SEGPAX	LF	WDCA	NDCA	WIAD	NIAD
1	NYC	WAS	215	31.7	0	3170	100	0	62.6	0.0	0.0	0.0	0.0	3170	0	0	0	0	3170	53.0	0.0	58.1	4.4	0.0
2	ALT	WAS	540	54.2	0	567	100	0	22.5	0.0	0.0	0.0	0.0	567	0	0	0	0	954	53.0	0.0	22.5	0.0	0.0
3	BOS	WAS	406	44.9	0	1115	100	0	33.7	0.0	0.0	0.0	0.0	1115	0	0	0	0	1428	53.0	0.0	21.6	0.0	12.1
4	ORD	WAS	591	57.8	0	1089	100	0	30.0	0.0	0.0	0.0	0.0	1089	0	0	0	0	1274	53.0	0.0	30.0	0.0	0.0
5	CLE	WAS	297	37.4	0	85	100	0	3.5	0.0	0.0	0.0	0.0	85	0	0	0	0	147	53.0	0.0	3.5	0.0	0.0
6	DET	WAS	391	43.9	0	483	100	0	13.1	0.0	0.0	0.0	0.0	483	0	0	0	0	483	46.3	0.0	13.1	0.0	0.0
7	MIA	WAS	920	80.5	0	419	100	0	11.2	0.0	0.0	0.0	0.0	419	0	0	0	0	475	53.0	0.0	11.2	0.0	0.0
8	MSP	WAS	919	80.5	0	267	100	0	6.9	0.9	0.0	0.0	0.0	227	40	0	0	0	291	53.0	0.0	6.9	0.0	0.0
9	PHL	WAS	133	26.0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0
10	PIT	WAS	193	30.1	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0
11	STL	WAS	707	65.8	0	273	100	0	6.7	0.0	0.0	0.0	0.0	273	0	0	0	0	394	53.0	0.0	5.7	1.0	0.0
12	TPA	WAS	810	73.0	0	160	100	0	0.1	7.9	0.0	0.0	0.0	12	148	0	0	0	12	53.0	0.0	0.0	0.1	0.0
13	MSY	WAS	962	83.5	0	107	100	0	3.5	0.0	0.0	0.0	0.0	107	0	0	0	0	149	53.0	0.0	0.0	0.0	3.5
14	DFW	WAS	1161	97.2	0	300	100	0	6.3	6.4	0.0	0.0	0.0	263	37	0	0	0	303	53.0	0.0	0.0	0.3	5.9
15	DEN	WAS	1476	119.1	0	221	100	0	0.5	7.4	0.0	0.0	0.0	84	137	0	0	0	84	53.0	0.0	0.0	0.5	0.0
16	HOU	WAS	1204	100.3	0	163	100	0	3.2	5.0	0.0	0.0	0.0	60	102	0	0	0	138	53.0	0.0	0.0	0.0	3.2
17	LAX	WAS	2288	175.4	0	682	100	0	3.6	14.7	0.0	0.0	0.0	569	113	0	0	0	570	53.0	0.0	0.0	3.6	0.0
18	SFO	WAS	2430	185.2	0	437	100	0	8.3	0.0	0.0	0.0	0.0	437	0	0	0	0	438	53.0	0.0	0.0	0.7	7.6
19	MKI	WAS	932	81.4	0	163	100	0	3.8	4.7	0.0	0.0	0.0	89	73	0	0	0	163	53.0	0.0	0.0	0.0	3.8
20	SEA	WAS	2317	177.3	0	139	100	0	0.0	12.5	0.0	0.0	0.0	0	139	0	0	0	0	0.0	0.0	0.0	0.0	0.0
21	LAS	WAS	2077	160.8	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0

TABLE 1B

Washington Segment Data

Scenario: 1975; Wide-Bodies Allowed at National

Quota: 40 Operations/Hour

CITY PAIR DATA:

						MARKET DATA														SEGMENT DATA					
NO.	-PAIR--		DIST	FARE	%PLES	PAX	%B	%N	FREQUENCY, 0-4 STOP					PAX, 0 TO 4 STOPS					SEGPAX	LF	WDCA	NDCA	WIAD	NIAD
1	NYC	WAS	215	31.7	0	3170	100	0	61.7	0.0	0.0	0.0	0.0	3170	0	0	0	0	3170	53.0	4.8	56.9	0.0	0.0
2	ALT	WAS	540	54.2	0	567	100	0	22.5	0.0	0.0	0.0	0.0	567	0	0	0	0	954	53.0	0.0	22.5	0.0	0.0
3	BOS	WAS	406	44.9	0	1115	100	0	33.7	0.0	0.0	0.0	0.0	1115	0	0	0	0	1428	53.0	0.0	21.6	0.0	12.1
4	ORD	WAS	591	57.8	0	1089	100	0	30.0	0.0	0.0	0.0	0.0	1089	0	0	0	0	1311	53.0	0.3	29.7	0.0	0.0
5	CLE	WAS	297	37.4	0	58	100	0	2.4	0.0	0.0	0.0	0.0	58	0	0	0	0	100	53.0	0.0	2.4	0.0	0.0
6	DET	WAS	391	43.9	0	483	100	0	13.1	0.0	0.0	0.0	0.0	483	0	0	0	0	483	46.3	0.0	13.1	0.0	0.0
7	MIA	WAS	920	80.5	0	419	100	0	11.2	0.0	0.0	0.0	0.0	419	0	0	0	0	475	53.0	0.0	11.2	0.0	0.0
8	MSP	WAS	919	80.5	0	267	100	0	7.5	0.0	0.0	0.0	0.0	267	0	0	0	0	316	53.0	0.0	7.5	0.0	0.0
9	PHL	WAS	133	26.0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0
10	PIT	WAS	193	30.1	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0
11	STL	WAS	707	65.8	0	273	100	0	6.5	0.0	0.0	0.0	0.0	273	0	0	0	0	415	53.0	1.2	5.3	0.0	0.0
12	TPA	WAS	810	73.0	0	160	100	0	0.1	7.9	0.0	0.0	0.0	12	148	0	0	0	12	53.0	0.1	0.0	0.0	0.0
13	MSY	WAS	962	83.5	0	107	100	0	3.5	0.0	0.0	0.0	0.0	107	0	0	0	0	149	53.0	0.0	0.0	0.0	3.5
14	DFW	WAS	1161	97.2	0	300	100	0	6.3	6.4	0.0	0.0	0.0	263	37	0	0	0	303	53.0	0.0	0.0	0.3	5.9
15	DEN	WAS	1476	119.1	0	221	100	0	0.3	7.7	0.0	0.0	0.0	52	169	0	0	0	52	53.0	0.0	0.0	0.3	0.0
16	HOU	WAS	1204	100.3	0	163	100	0	3.2	5.0	0.0	0.0	0.0	60	102	0	0	0	138	53.0	0.0	0.0	0.0	3.2
17	LAX	WAS	2288	175.4	0	682	100	0	3.3	15.0	0.0	0.0	0.0	525	157	0	0	0	525	53.0	0.0	0.0	3.3	0.0
18	SFO	WAS	2430	185.2	0	437	100	0	8.3	0.0	0.0	0.0	0.0	437	0	0	0	0	438	53.0	0.0	0.0	0.7	7.6
19	PKI	WAS	932	81.4	0	160	100	0	4.0	4.0	0.0	0.0	0.0	98	62	0	0	0	171	53.0	0.0	0.0	0.0	4.0
20	SEA	WAS	2317	177.3	0	137	100	0	0.0	11.6	0.0	0.0	0.0	0	137	0	0	0	0	0.0	0.0	0.0	0.0	0.0
21	LAS	WAS	2077	160.8	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0

TABLE 1C

Washington Segment Data

Scenario: 1975; Wide-Bodies Allowed at National

Quota: 30 Operations/Hour

								MARKET DATA											SEGMENT DATA					
#.	-PAIR--		DIST	FARE	%PLES	PAX	%B	%W	FREQUENCY, 0-4 STOP					PAX, 0 TO 4 STOPS					SEGPAX	LF	WDCA	NDCA	WIAD	NIAD
1	NYC	WAS	215	31.7	0	3170	100	0	64.1	0.0	0.0	0.0	0.0	3170	0	0	0	0	3170	53.0	3.9	48.3	0.0	11.9
2	ALT	WAS	540	54.2	0	567	100	0	23.3	0.0	0.0	0.0	0.0	567	0	0	0	0	987	53.0	0.0	19.4	0.0	3.9
3	BOS	WAS	406	44.9	0	1115	100	0	33.8	0.0	0.0	0.0	0.0	1115	0	0	0	0	1434	53.0	0.0	20.0	0.0	12.9
4	ORD	WAS	591	57.8	0	1089	100	0	30.0	0.0	0.0	0.0	0.0	1089	0	0	0	0	1311	53.0	0.3	29.7	0.0	0.0
5	CLE	WAS	297	37.4	0	58	100	0	2.4	0.0	0.0	0.0	0.0	58	0	0	0	0	100	53.0	0.0	2.4	0.0	0.0
6	DET	WAS	391	43.9	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0
7	MIA	WAS	920	80.5	0	419	100	0	11.2	0.0	0.0	0.0	0.0	419	0	0	0	0	475	53.0	0.0	11.2	0.0	0.0
8	MSP	WAS	919	80.5	0	267	100	0	7.5	0.0	0.0	0.0	0.0	267	0	0	0	0	316	53.0	0.0	7.5	0.0	0.0
9	PHL	WAS	133	26.0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0
10	PIT	WAS	193	30.1	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0
11	STL	WAS	707	65.8	0	273	100	0	6.5	0.0	0.0	0.0	0.0	273	0	0	0	0	415	53.0	1.2	5.3	0.0	0.0
12	TPA	WAS	810	73.0	0	160	100	0	0.0	8.0	0.0	0.0	0.0	3	157	0	0	0	3	53.0	0.0	0.0	0.0	0.0
13	MSY	WAS	962	83.5	0	107	100	0	3.5	0.0	0.0	0.0	0.0	107	0	0	0	0	149	53.0	0.0	0.0	0.0	3.5
14	DFW	WAS	1161	97.2	0	300	100	0	6.7	5.5	0.0	0.0	0.0	263	37	0	0	0	286	53.0	0.0	0.0	0.0	6.7
15	DEN	WAS	1476	119.1	0	221	100	0	0.3	7.7	0.0	0.0	0.0	52	169	0	0	0	52	53.0	0.0	0.0	0.3	0.0
16	HOU	WAS	1204	100.3	0	163	100	0	3.2	5.0	0.0	0.0	0.0	60	102	0	0	0	138	53.0	0.0	0.0	0.0	3.2
17	LAX	WAS	2288	175.4	0	682	100	0	3.3	15.0	0.0	0.0	0.0	525	157	0	0	0	525	53.0	0.0	0.0	3.3	0.0
18	SFO	WAS	2430	185.2	0	437	100	0	8.3	0.0	0.0	0.0	0.0	437	0	0	0	0	438	53.0	0.0	0.0	0.7	7.6
19	MKI	WAS	932	81.4	0	160	100	0	4.0	4.0	0.0	0.0	0.0	98	62	0	0	0	171	53.0	0.0	0.0	0.0	4.0
20	SEA	WAS	2317	177.3	0	137	100	0	0.0	11.6	0.0	0.0	0.0	0	137	0	0	0	0	0.0	0.0	0.0	0.0	0.0
21	LAS	WAS	2077	160.8	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0

TABLE ID

Washington Segment Data

Scenario: 1975; Wide-Bodies Allowed at National

Quota: 20 Operations/Hour

CITY PAIR DATA:

				MARKET DATA															SEGMENT DATA					
NO.	-PAIR--		DIST	FARE	%PLES	PAX	%B	%N	FREQUENCY, 0-4 STOP					PAX, 0 TO 4 STOPS					SEGPAX	LF	WDCA	NDCA	WIAD	NIAD
1	NYC	WAS	215	31.7	0	3170	100	0	74.6	0.0	0.0	0.0	0.0	3170	0	0	0	0	3170	53.0	0.0	9.4	0.0	65.4
2	ALB	WAS	540	54.2	0	557	100	0	24.2	0.0	0.0	0.0	0.0	557	0	0	0	0	1027	53.0	0.0	15.5	0.0	5.6
3	BOS	WAS	406	44.9	0	1115	100	0	34.1	0.0	0.0	0.0	0.0	1115	0	0	0	0	1514	53.0	0.6	19.3	0.0	14.2
4	[illegible]	WAS	591	57.8	0	1089	100	0	30.0	0.0	0.0	0.0	0.0	1089	0	0	0	0	1314	53.0	0.4	29.5	0.0	0.0
5	CLE	WAS	297	37.4	0	44	100	0	2.3	0.0	0.0	0.0	0.0	44	0	0	0	0	96	53.0	0.0	0.0	0.0	2.3
6	DET	WAS	391	43.9	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0
7	MIA	WAS	920	80.5	0	419	100	0	11.2	0.0	0.0	0.0	0.0	419	0	0	0	0	475	53.0	0.0	11.2	0.0	0.0
8	MSP	WAS	919	80.5	0	267	100	0	7.5	0.0	0.0	0.0	0.0	267	0	0	0	0	316	53.0	0.0	7.5	0.0	0.0
9	PHL	WAS	133	26.0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0
10	PIT	WAS	193	30.1	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0
11	STL	WAS	707	65.8	0	273	100	0	6.5	0.0	0.0	0.0	0.0	273	0	0	0	0	429	53.0	1.3	5.2	0.0	0.0
12	TPA	WAS	810	73.0	0	160	100	0	0.0	8.0	0.0	0.0	0.0	3	157	0	0	0	3	53.0	0.0	0.0	0.0	0.0
13	MSY	WAS	962	83.5	0	107	100	0	3.5	0.0	0.0	0.0	0.0	107	0	0	0	0	149	53.0	0.0	0.0	0.0	3.5
14	DFW	WAS	1161	97.2	0	300	100	0	7.7	3.8	0.0	0.0	0.0	263	37	0	0	0	326	53.0	0.0	0.0	0.0	7.7
15	DEN	WAS	1476	119.1	0	221	100	0	0.2	7.8	0.0	0.0	0.0	35	185	0	0	0	35	53.0	0.0	0.0	0.2	0.0
16	HOU	WAS	1204	100.3	0	163	100	0	3.2	5.0	0.0	0.0	0.0	60	102	0	0	0	138	53.0	0.0	0.0	0.0	3.2
17	LAX	WAS	2288	175.4	0	682	100	0	3.2	15.2	0.0	0.0	0.0	510	172	0	0	0	510	53.0	0.0	0.0	3.2	0.0
18	SFO	WAS	2430	185.2	0	437	100	0	8.3	0.0	0.0	0.0	0.0	437	0	0	0	0	438	53.0	0.0	0.0	0.7	7.6
19	MKE	WAS	932	81.4	0	159	100	0	4.1	3.7	0.0	0.0	0.0	101	57	0	0	0	174	53.0	0.0	0.0	0.0	4.1
20	SEA	WAS	2317	177.3	0	137	100	0	0.0	11.6	0.0	0.0	0.0	0	137	0	0	0	0	0.0	0.0	0.0	0.0	0.0
21	LAS	WAS	2077	160.8	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0

operations/hour at National airport.

For each city pair, the fare and the number of origin and destination passengers, as well as the total number of passengers carried on that link are shown, together with the number of flights per day of narrow and wide-body aircraft into National and Dulles. The Tables basically show that as the quota is decreased, the aircraft in the short haul markets, which are less profitable than the longer haul markets, shift to Dulles airport. In order to maintain passenger appeal, however, the frequency into Dulles is increased to stimulate demand. The same phenomenon occurs at 1985, 1990 and 1995 traffic levels.

Both Table 1 and 3 possess the same structure; however, in the latter the number of passengers into Dulles and National are shown. The passengers carried into National on both types of aircraft decreased along with frequencies as the various quotas were imposed for each year. Since there was a general increase of flights into Dulles for the same conditions, the number of passengers increased as expected. This variation of passengers with frequency of service can also be identified if relevant figures of Table 3 are compared with those of Table 2. Table 3 reveals that it is quite feasible to substitute wide-bodies for narrow into National and still divert a relatively small amount of the total passengers to Dulles. It is important to note, however, that this is achieved best within each year for the quota of 40 operations per hour. At this level both the number of wide-bodies and percentage of passengers into National are the largest. This phenomenon also occurs at 30 operations but it is not as clear. At twenty operations per hour a complete traffic reversal occurs. Wide-bodies into National are drastically reduced; however, they form a substantial part of the Dulles

Passengers into Dulles and National*

	Total Departures	Limit On Dep	National WDCA	National NDCA	Dulles WIAD	Dulles NIAD	Total DCA	Total IAD	Total WAS
1975	219	200	0	7314	1685	1539	7314	3224	10538
	218	200	1017	7208	747	5803	8225	6550	14775
	208	150	858	6131	699	2285	6989	2985	9974
	227	100	365	4142	667	4948	4508	5615	10124
1985	254	200	7027	6605	3354	1416	13633	4771	18404
	262	150	6407	4647	3450	3832	11054	7283	18337
	272	100	2448	3587	6980	5439	6035	12420	18455
1990	260	200	10971	5554	3959	1496	16525	5455	21981
	270	150	9428	3845	4849	3794	13274	8644	21918
	282	100	5119	2874	8427	5486	7994	13913	21908
1995	280	200	15216	4422	5596	1912	19638	7509	27147
	291	150	13801	2679	6391	4269	16480	10661	27142
	300	100	6264	2569	13292	4952	8834	18244	27078

TABLE 3

* This traffic constitutes only those passengers into Washington from the other 22 large hubs considered.

traffic. The ratio of passengers becomes 2:1 in favor of Dulles, as noted earlier due to the demand stimulated by higher frequencies.

Finally, an investigation was pursued regarding the changes in service if all large hubs were allowed direct service into National. The most significant change from the group 2 cities occurred for San Francisco where seven wide-body vehicles were assigned direct service into National; no other cities from this group were provided direct service. This proved interesting since a strong market such as Los Angeles was still denied a direct connection. The results seem to support the theory that passengers in relatively distant markets are indifferent towards their final Washington airport destination. Table 4 shows the results for all Washington city-pairs with 1995 demand and a quota of 20 operations/hour. At Washington airports the effect of lifting the perimeter restrictions results in little change in the total aircraft mix as well, as seen below.

1995: Quota = 20 Operations/Hour

	WDCA	NDCA	WIAD	NIAD
With Perimeter Rule	39.4	60.6	83.6	116.8
Without Perimeter Rule	41.1	58.9	81.2	121.7

TABLE 4

Washington Segment Data

Scenario: 1995; Perimeter Restriction Lifted

Quota: 20 Operations/Hour

CITY PAIR DATA:

NO.	-PAIR--		DIST	FARE	%PLES	PAX	%B	%N	FREQUENCY, 0-4 STOP					PAX, 0 TO 4 STOPS					SEGPAX	LF	WDCA	NDCA	WIAD	NIAD
						MARKET DATA													SEGMENT DATA					
1	NYC	WAS	215	31.7	0	7954	100	0	77.1	0.0	0.0	0.0	0.0	7954	0	0	0	0	7954	53.0	0.0	0.0	40.2	36.9
2	ALT	WAS	540	54.2	0	1422	100	0	26.8	0.0	0.0	0.0	0.0	1422	0	0	0	0	1423	53.0	0.0	5.4	2.5	18.9
3	BOS	WAS	406	44.9	0	2798	100	0	37.1	0.0	0.0	0.0	0.0	2798	0	0	0	0	2799	53.0	4.2	3.8	6.4	22.7
4	ORD	WAS	591	57.8	0	2734	100	0	30.0	0.0	0.0	0.0	0.0	2734	0	0	0	0	2893	53.0	13.9	16.1	0.0	0.0
5	CLE	WAS	297	37.4	0	775	100	0	12.9	0.0	0.0	0.0	0.0	775	0	0	0	0	841	53.0	0.8	9.9	1.7	0.5
6	DET	WAS	391	43.9	0	1213	100	0	14.3	0.0	0.0	0.0	0.0	1213	0	0	0	0	1213	53.0	5.2	2.8	0.0	6.3
7	MIA	WAS	920	80.5	0	1053	100	0	11.2	0.0	0.0	0.0	0.0	1053	0	0	0	0	1053	53.0	5.0	6.2	0.0	0.0
8	MSP	WAS	919	80.5	0	763	100	0	8.1	7.5	0.0	0.0	0.0	697	66	0	0	0	889	53.0	2.6	3.5	2.1	0.0
9	PHL	WAS	133	26.0	0	34	100	0	2.0	0.0	0.0	0.0	0.0	34	0	0	0	0	84	53.0	0.0	0.0	0.0	2.0
10	PIT	WAS	193	30.1	0	848	100	0	16.7	0.0	0.0	0.0	0.0	848	0	0	0	0	849	53.0	0.0	0.0	1.2	15.5
11	STL	WAS	707	65.8	0	841	100	0	13.0	0.0	0.0	0.0	0.0	841	0	0	0	0	887	53.0	2.9	10.1	0.0	0.0
12	TPA	WAS	810	73.0	0	402	100	0	2.5	5.4	0.0	0.0	0.0	402	0	0	0	0	403	53.0	0.0	0.0	2.5	0.0
13	MSY	WAS	962	83.5	0	364	100	0	7.0	0.0	0.0	0.0	0.0	364	0	0	0	0	364	53.0	0.0	0.0	0.6	6.5
14	DFW	WAS	1161	97.2	0	754	100	0	7.8	3.6	0.0	0.0	0.0	754	0	0	0	0	754	53.0	0.0	0.0	3.6	4.2
15	DEN	WAS	1476	119.1	0	672	100	0	3.9	10.1	0.0	0.0	0.0	627	45	0	0	0	627	53.0	0.0	0.0	3.9	0.0
16	HOU	WAS	1204	100.3	0	456	100	0	4.8	8.3	0.0	0.0	0.0	456	0	0	0	0	456	53.0	0.0	0.0	2.2	2.6
17	LAX	WAS	2288	175.4	0	1934	100	0	12.2	20.9	0.0	0.0	0.0	1934	0	0	0	0	1934	53.0	0.0	0.0	12.2	0.0
18	SFO	WAS	2430	185.2	0	1097	100	0	7.6	0.0	0.0	0.0	0.0	1097	0	0	0	0	1098	53.0	6.7	0.9	0.0	0.0
19	MKI	WAS	932	81.4	0	448	100	0	7.2	2.8	0.0	0.0	0.0	448	0	0	0	0	497	53.0	0.0	0.0	1.6	5.6
20	SEA	WAS	2317	177.3	0	349	100	0	0.0	11.7	0.0	0.0	0.0	0	349	0	0	0	0	0.0	0.0	0.0	0.0	0.0
21	LAS	WAS	2077	160.8	0	93	100	0	0.6	6.9	0.0	0.0	0.0	93	0	0	0	0	94	53.0	0.0	0.0	0.6	0.0

4. Conclusions

It appears that wide-bodies at National Airport would benefit both airline and the traveling public. By 1990, wide-body aircraft, if authorized, would constitute approximately 20 percent of all air carrier operations at National. This is equivalent to an average flight schedule of four wide-body departures per hour.